Directly Observed Physical Activity among 3-Year-Olds in Finnish Childcare

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ORIGINAL ARTICLE

Directly Observed Physical Activity among 3-Year-Olds in Finnish Childcare

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Abstract The main purpose of the study was to determine 3-year-olds' physical activity levels and how these vary across season, gender, time of day, location, and the physical and social environment in childcare settings in Finland. A modified version of the Observational System for Recording Physical Activity in Children-Preschool (OSRAC-P) was used to measure physical activity levels and contextual variables (e.g., group composition, prompts) of children attending childcare centres. In total, 81 children (42 boys and 39 girls) were observed in autumn and in winter. Three-level linear regression analyses were used to assess differences between the seasons in the association between the context variables and physical activity. During the observations, the present sample of children was mostly sedentary in nature, engaging in moderate to vigorous physical activity in only 2 % of all observations. The results further showed a significant difference between season and the children's physical activity levels: in winter, the children spent significantly more time in sedentary-level activities and less time in moderate to vigorous physical activity than in autumn. The present sample of children was physically more active outdoors than indoors. Boys showed significantly higher physical activity levels than girls. The majority of the observations did not include any oral prompting. We conclude that childcare centres offer good opportunities to increase

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children's physical activity. Interventions should focus on enhancing children's outdoor time, free play, and positive prompting and encouragement by teachers.

Keywords Childcare · Direct observation · Physical activity · Preschool children

Résumé L'objectif principal de l'étude était de déterminer les niveaux d'activité physique chez les enfants de trois ans, et la façon dont ils varient selon la saison, le sexe, le moment de la journée, le lieu et l'environnement physique et social dans les garderies en Finlande. Une version modifiée de l'Observational System for Recording Physical Activity in Children-Preschool (OSRAC-P) a été utilisée pour mesurer les niveaux d'activité physique et les variables contextuelles (notamment, la composition du groupe, les incitations) des enfants fréquentant les garderies. Au total, 81 enfants (42 garçons et 39 filles) ont été observés en automne et en hiver. Des analyses de régression linéaire à trois niveaux ont servi à évaluer les différences entre les saisons en lien avec les variables contextuelles et activité physique. Au cours des observations, l'échantillon d'enfants était principalement de nature sédentaire avec une activité physique d'intensité modérée à élevée dans seulement 2 % de toutes les observations. Les résultats ont aussi révélé une différence significative entre la saison et les niveaux d'activité physique, en hiver les enfants passant sensiblement plus de temps dans des activités de niveau sédentaire et moins de temps dans des activités d'intensité modérée à élevée qu'en automne. L'échantillon d'enfants était physiquement plus actif à l'extérieur qu'à l'intérieur. Les garçons avaient des niveaux d'activité nettement plus élevés que les filles. La majorité des observations ne présentait aucune incitation verbale. Nous en concluons que les garderies offrent de bonnes possibilités pour augmenter l'activité physique des enfants. Les interventions devraient se concentrer sur l'augmentation du temps passé à l'extérieur, le jeu libre ainsi que l'incitation positive et l'encouragement des éducateurs.

Resumen El objetivo principal del estudio fue determinar los niveles de actividad física (AF) y cómo estos varían en relación a la estación, al género, el momento del día y al ambiente físico y social de un centro de cuidado en Finlandia. Durante el día en la guardería, los niveles de actividad física y las variables contextuales (como la composición del grupo o incentivo) fueron determinados con un método de observación modificado de OSRAC-P (Observational System for Recording Physical Activity in Children - Preschool Version). En total 81 niños (42 niños, 39 niñas) participaron en las observaciones durante otoño e invierno. Análisis lineales de regresiones de tres niveles fueron utilizados para evaluar las diferencias entre las estaciones climáticas en relación con los contextos variables elegidos y la actividad física. Durante las observaciones, la muestra de niños fue, en su mayoría, naturalmente sedentaria, siendo semi-activa en solo un 2 % de todas las observaciones. Los resultados mostraron una diferencia significante entre estaciones climáticas y los niveles de actividad física de los niños: en invierno los niños pasaban la mayor parte del tiempo en actividades físicas de nivel sedentario y menos tiempo en actividades semi-activas que durante el otoño. Los niños y niñas que participaron en la investigación fueron físicamente más activos fuera que dentro de la guardería. La

actividad física de los niños fue de nivel más alto que el la de las niñas. La mayoría de las observaciones no incluyeron un incentivo verbal. En base a los resultados podemos concluir que las guarderías ofrecen buenas oportunidades para aumentar la actividad física de los niños. Las intervenciones tendrían que centrarse en el aumento de actividades al aire libre, de juego espontáneo y de consejos positivos e incentivo por parte de los/las educadores/as preescolares.

Behavioural habits, such as physical activity and sedentary behaviours, are formed in early childhood (Janz et al. 2005; Timmons et al. 2007; Ward et al. 2010). Physical activity in preschool children (age 3–5 years) may be described as "play", and occurs at various levels of intensity (Timmons et al. 2007). Play, like learning, is a natural component of a child's everyday life and assists the child to make sense of his or her world (Pramling Samuelsson and Asplund Carlsson 2008). Further, physical activity has been found to have a positive effect on children's physical, cognitive, emotional and social development (Timmons et al. 2007; Ward 2010). An active lifestyle in childhood serves as the foundation for an active lifestyle later in life (Janz et al. 2005; Singh et al. 2008). Therefore, the enhancement of physical activity and reduction in sedentary behaviour in early childhood are important from a public health perspective (Strong et al. 2005; Tremblay et al. 2011).

Various studies have shown that the childcare centres children attend influence in their levels of physical activity (Bower et al. 2008; Finn et al. 2002; Pate et al. 2004, 2008; Ward 2010). Typically, very low physical activity levels and very high sedentary-level activity have been reported among preschool children during attendance at childcare settings (Brown et al. 2009; Gubbels et al. 2011; Oliver et al. 2007; Pate et al. 2008; Reilly 2010). Features of the physical environment of the childcare setting, such as the ground surface, playground markings, open space, and the availability of play equipment, have previously been linked to higher levels of physical activity (Bower et al. 2008; Cardon et al. 2008; Cosco et al. 2010; Hannon and Brown 2008; Gubbels et al. 2012; Nicaise et al. 2011; Ridgers et al. 2007). Children have been shown to be more active when they spend more time outdoors (Boldeman et al. 2006; Finn et al. 2002; Bower et al. 2008; Pate et al. 2004) and when recess is shorter in duration (Cardon et al. 2008; Dowda et al. 2004). Furthermore, children's physical activity has been observed to increase in warm seasons and decrease in colder seasons (Carson and Spence 2010; Fisher et al. 2005; Poest et al. 1989). Factors related to the social environment, such as positive prompts by teachers or peers, have also been associated with increased physical activity (Brown et al. 2009; Gubbels et al. 2011). Despite this positive association, Brown et al. (2009) reported that teachers and peers rarely prompt children to raise their level of physical activity. Finally, child-initiated instead of teacher-initiated play (Brown et al. 2009), smaller group size (Brown et al. 2009; Cardon et al. 2008) and higher educational level of teachers (Dowda et al. 2004) have been linked to increased levels of children's physical activity.

Although studies assessing physical activity and sedentary behaviour in preschool children have increased over the past decade (Bornstein et al. 2011),

observational research yielding contextual information to promote physical activity is still lacking, especially in Europe (Bower et al. 2008; Brown et al. 2009; Gubbels et al. 2011). Additionally, only a small set of studies exists where preschool children's physical activity levels have been determined during different seasons (Carson and Spence 2010). An improved understanding of the determinants of physical activity in the childcare setting could support the development of interventions aimed at promoting physical activity levels of younger preschool children throughout the year. Therefore, the purpose of this study was to examine Finnish 3-year-olds' physical activity levels and sedentary behaviour during attendance at childcare, and their seasonal variation, related demographic and biological characteristics, and physical and social contexts.

Methods

Sample and Data Collection

Participants were recruited in a city in central Finland. Principals of childcare centres were provided with information regarding the study at a regional administrative meeting. A total of 14 childcare centres volunteered their involvement in the study. The childcare centres were situated in different environmental and socioeconomic neighbourhoods in the city. All the families of the 3-year-old children (year of birth 2007) attending the participating childcare centres were invited to join the study. The parents of 102 (57 %) of the 179 families provided informed consent.

The children's physical activity data were collected in two phases using a repeated-measure design. The first data collection phase was between August and October 2010 (autumn), and the second between January and February 2011 (winter). A total of 96 children (48 boys and 48 girls) participated in the autumn data collection and 94 children (50 boys and 44 girls) in the corresponding winter collection. Data from both collection phases were gathered for 81 children (42 boys and 39 girls).

Instruments

A modified version of the Observational System for Recording Physical Activity in Children-Preschool Version (OSRAC-P; Brown et al. 2006) was used to measure children's physical activity intensity, type of activity, location, contexts, prompts and interactions. Two trained researchers observed the children's physical activity and contextual factors using a procedure in which 15 s of observation were followed by 30 s of recorded observation. The observation sheets were completed manually and the procedure was repeated eight times over 6 min for each child. Each child was observed at least twice per day, in the morning (between 8 a.m. and 12 p.m.) and in the afternoon (between 2 p.m. and 5 p.m.), including indoor and outdoor observations, during three consecutive days (from Wednesday to Friday). Children were randomly selected for observation and were not observed during the scheduled meal or rest times. The data collection was conducted without disturbing the daily routines of the childcare centres and without undue influence on the children or teachers.

Children's physical activity intensity levels were measured on a five-point scale (1 = stationary or motionless, 2 = stationary with limb or trunk movements, 3 = slow or easy movements, 4 = moderate movements, and 5 = fast movements) and reflected the highest intensity level reached by the child during each 15-s observation interval. For the purpose of this study and further comparison, activity levels 1–2 were regarded as sedentary-level activity, activity level 3 as light physical activity and levels 4–5 as moderate to vigorous physical activity (Bower et al. 2008; Brown et al. 2009; Gubbels et al. 2011; Nicaise et al. 2011; Pate et al. 2008).

OSRAC-P scales assessing contextual variables such as time of day and primary location were used. In addition, the following social OSRAC-P scales were assessed: group composition, initiator of activity and prompts. In the present study, Brown et al. (2006) original 18 activity-type codes (e.g., *sitting*, *standing* and *running*) were complemented with four typical Finnish types of activity (i.e., *balancing, sliding, skiing and ice-skating*) and used as descriptive categories. Finally, the indoor contexts were complemented with *toys* (e.g., playing with cars, dolls), *household chores* (e.g., baking, cleaning), *temper tantrum* (e.g., crying, refusing to participate in indoor activities) and *small-group* (participating group activities, less than half of the children); and outdoor contexts with *temper tantrum* (e.g., crying, refusing to participate outdoor activities), *forest* (e.g., natural environment outside the childcare centre), *sport field* (e.g., sport track, ice rink, ski path) and *transitions* (lining up and waiting to move, or moving from one activity area to another area).

Background Information

Weather conditions and outdoor temperatures were recorded per observation day. Body weight and height of the children were measured between the two observation phases at the time of the physical activity data collection, and body mass index (BMI: kg/m^2) was calculated for each child. The BMI results indicated, in accordance with the International Obesity Task Force BMI definition, that nine children (12 %) during the autumn assessments and six children (8 %) during the winter assessments were overweight. All the other children were in the normal BMI range (Cole et al. 2000). Background information on children's attendance times was recorded in diaries kept by the children's parents. Outdoor times were recorded by the researchers during the observation days. In general, Finnish childcare centre hours are from 6.30 a.m. to 5 p.m. Meal (i.e., breakfast at 8 a.m., lunch 11.30 a.m. and snacks at 2 p.m.) and rest times give a rhythm to the childcare centre's daily schedule. Typically, a childcare day includes two outdoor recess periods, one in the morning and one in the afternoon. The ethics committee of the local university, and the city's social affairs and health officer approved the study.

Statistical Analyses

The observers' scores for the dichotomous variables (e.g., prompt by teacher, yes/no) were combined by coding the variable as present (1) when one or both observers rated that variable as present, and coding it as absent (0) when both rated it as absent. For continuous variables (e.g., activity intensity), the mean of the scores of both observers

was calculated. Cohen's kappa was used to determine the inter-rater reliability (IRR) of the two observers during the observations of the OSRAC-P variables (i.e., activity intensity, activity types, group composition, contexts, initiator of activity and prompts). Mean IRR of the variables assessed was .70 (SD = 0.2; $p < .001$).

Various background characteristics were explored using descriptive statistics. General Linear Models (GLM) for repeated measures (MANOVA) were used to analyse differences between autumn and winter. Differences in the observed contextual variables between observations and seasons were examined using Chi square tests. The association between the mean level of physical activity intensity as the dependent variable and independent variables such as, gender (girl vs. boy), BMI (linear), primary location (outdoor vs. indoor), time of day (afternoon vs. morning), group composition (solitary vs. non-solitary), initiator of activity (adult vs. child), prompts (no prompts vs. negative or positive prompts), temperature (linear) and weather condition (rain vs. sunny, with clear sky or cloudy but dry), was examined using three-level linear regression. All analyses were performed using SPSS 18.0 and STATA 12. In all analyses, p values $< .05$ were considered statistically significant.

Results

Childcare and Outdoor Times, Temperature and Weather Conditions

During the data collection periods, the participants attended their childcare settings for approximately 7.7 h/day in the autumn and 7.5 h/day in the winter. A total of 1 978 observations and 15,824 single observation intervals (1,978 × 8 times) were analysed; 966 observations (an average 5.96 (SD = 2.49) observations/child) were observed in the autumn and 1,012 observations (an average 6.25 (SD = 2.96) observations/child) in the winter. The results indicated a significant difference between autumn and winter in mean outdoor time during childcare attendance (minutes per day 179 vs. 120, respectively; $p = .002$). The mean outdoor temperature was 11.6 °C during the autumn observations (range −2 to 20 °C) and −9.9 °C during the winter observations (range −30 to 2 °C). The differences between the autumn and winter mean temperatures were significant ($p < .001$). Most of the time, the weather was cloudy but dry (49 % autumn; 51 % winter) or sunny with a clear sky (27 % autumn; 36 % winter); the least prevalent weather type was precipitation of rain (23 % autumn) or snow (13 % winter). The differences between the seasons in the percentages of intervals observed in the different temperature categories and weather conditions, and in engagement in sedentary-level activity, light physical activity and moderate to vigorous physical activity associated with these categories, are described in Table 1.

Prevalence of Contextual Variables and Physical Activity Levels

During the observations, the children's physical activity levels were mostly sedentary: 69 % (indoors 86 %; outdoors 46 %) of total intervals were recorded as sedentary, and only 2 % (indoors 1 %; outdoors 2 %) as moderate to vigorous

physical activity. The initiators of activities were most frequently children (77 %), and the children's play was most frequently non-solitary (74 %). Teachers or peers rarely prompted children to increase or decrease their physical activity: no prompts were recorded in 92 % of all observations. In prevalence (%) of observations, significant seasonal differences were found in all the variables, except gender and time of day (see Table 1).

In winter, the children engaged in moderate to vigorous physical activity outdoors significantly less in than in autumn. Seasonal variations were observed in boys' but not in girls' physical activity levels. The percentages of physical activity in the categories sedentary, light and moderate to vigorous physical activity observed during autumn and winter are shown in Table 1.

Activity Types, Indoor and Outdoor Contexts and Physical Activity Levels

In both seasons, the three most frequently observed physical activity types were (1) *sitting/squatting/kneeling*, (2) *walking/marching* and (3) *standing*. In the autumn, the most frequently observed *indoor activity variables* were (1) *toys* (25 %) (2) *other* (25 %; e.g., being in some other indoor context or engaging in some activity other than the option listed, and (3) *sociodramatic* (8 %), whereas in the winter these were (1) *toys* (36 %), (2) *other* (26 %), (3) *art* (9 %) and *transition* (9 %; both lining up or moving from one activity context to another area). When examined more closely for seasonal variations, several differences in the activity variables were found; in the autumn, the children were engaged significantly more frequently in the variables *large blocks* ($p = .007$), *manipulative* ($p = .017$), *music* ($p = .035$), *snacks* ($p < .001$) and *self-care* ($p = .013$) than in the winter, during which the children more often played with *toys* ($p < .001$) and engaged in *art* activities ($p = .009$) than in the autumn. The three most frequently observed *outdoor context* variables were (1) *open space* (30 %), (2) *sandbox* (20 %) and (3) *fixed equipment* (16 %) in the autumn, and (1) *open space* (26 %), (2) *portable equipment* (14 %), *and* (3) *fixed equipment* (13 %) in the winter. In the autumn, the children more frequently played in an *open outdoor area* ($p = .016$), touched, ride or pushed *wheeled* toys ($p < .001$), used *sandbox* materials or played in the sandbox ($p < .001$), played using *sociodramatic props* ($p = .003$), and engaged in *other* activities ($p < .001$) than in the winter. Finally, during the winter, the children more often made use of *portable equipment* (other than balls or wheeled toys) brought into the playground ($p < .001$) than in the autumn. The most common activity types, physical and social environments at the different levels of physical activity are shown in Table 2.

Associations Between Observed Contexts and Physical Activity in Autumn and in Winter

Gender was significantly associated with children's activity levels in both seasons. Boys showed significantly higher mean physical activity intensity levels than girls (activity intensity 2.42 vs. 2.24, respectively, $p < .001$). When controlled for other variables (i.e., gender, location, time of day, group composition, initiator of activity, prompts and weather conditions), BMI was not associated with children's activity

Table 1 Percentages of observations ($N = 15{,}824$) and percentages of observations in sedentary, light and moderate to vigorous physical activity in both seasons

Observed categories	Prevalence (%)		p value*	Activity levels (%)						p value**
	Autumn	Winter		Autumn			Winter			
				Sedentary	Light	MVPA	Sedentary	Light	MVPA	
All children				67.4	30.5	2.1	70.6	28.5	0.9	.046
Boys	51	52	.435	61.1	35.5	3.5	66.5	32.3	1.1	.017
Girls	50	48		73.8	25.5	0.6	74.7	24.6	0.6	.951
Location										
Indoor	52	63	<.001	85.5	13.3	1.2	86.0	13.1	0.9	.910
Outdoor	48	37		47.6	49.4	3.0	43.7	55.5	0.8	.028
Time										
Morning	57	56	.787	64.4	33.2	2.4	68.8	30.3	0.9	.066
Afternoon	43	44		71.3	27.0	1.7	72.5	26.6	0.9	.585
Morning										
Indoor	48	62	<.001	84.0	14.9	1.1	82.9	16.0	1.1	.931
Outdoor	52	38		46.5	50.0	3.5	46.3	53.2	0.5	.065
Afternoon										
Indoor	58	66	.021	87.2	11.6	1.2	89.7	9.6	0.7	.606
Outdoor	42	35		49.4	48.3	2.3	39.9	58.8	1.3	.150
Group composition										
Solitary	29.7	22.9	<.001	50.1	35.7	14.2	55.9	35.7	8.4	<.001
Non-solitary	70.3	77.1		60.5	27.5	11.9	61.9	27.8	10.3	.147
Initiator of activity										
Adult	25.2	20.8	<.001	68.3	23.5	8.2	72.0	19.8	8.3	.150
Child	74.8	79.2		53.8	32.1	14.1	57.5	32.2	10.3	<.001

Table 1 continued

Observed categories	Prevalence (%)		*p* value*	Activity levels (%)						*p* value**
	Autumn	Winter		Autumn			Winter			
				Sedentary	Light	MVPA	Sedentary	Light	MVPA	
Prompts										
No prompts	86.4	98.3	<.001	59.3	28.7	12.0	60.9	29.3	9.8	.009
All prompts	13.6	1.7		45.4	38.2	16.3	38.9	45.8	15.3	.451
Temperature										
10 °C or warmer	76.5	–	<.001	65.8	31.9	2.3	–	–	–	–
9–0 °C	23.1	4.4		72.2	26.5	1.3	75.6	24.4	–	.697
−1 to −9 °C	0.4	48.1		100	–	–	67.6	32.0	0.4	.384
−10 to −19 °C	–	36.3		–	–	–	71.7	26.4	1.9	–
−20 °C or colder	–	11.2		–	–	–	77.0	23.0	–	–
Weather										
Sunny with clear sky	27.3	36.3	<.001	68.2	28.8	3.0	71.9	27.5	0.5	.041
Cloudy but dry	49.4	50.9		64.4	33.8	1.9	72.4	26.2	1.4	.024
Rain or snow rain	23.3	12.8		72.9	25.8	1.3	58.5	41.5	–	.005

Sedentary = levels 1 and 2; light = level 3; moderate to vigorous physical activity (MVPA) = levels 4 and 5; *p* values* from Pearson Chi Square Tests to compare seasonal differences in observed intervals, and *p* values** from Pearson Chi Square Tests to compare percentages spent in sedentary, light, and moderate to vigorous levels physical activity

Table 2 The most common (at least 12 % of all observations) activity types, physical and social environments at different levels of physical activity in both seasons

Activity intensity	Activity type	Physical environment	Social environment
MVPA	Pull/push (0.9 %)	Indoor: group time (2.0 %), Toys (0.4 %)	Group composition: solitary (11.3 %)
	Climb (0.6 %)	Outdoor: wheel (2.1 %),	Initiator of activity: child (12.2 %)
	Run (0.6 %)	Open space (1.4 %)	Prompts: all prompts (31.6 %)
Light	Jump/skip (50.6 %)	Indoor: sociodramatic (19.1 %)	Group composition: solitary (35.7 %)
	Pull/push (49.8 %)	Other (15.3 %)	Initiator of activity: child (32.2 %
	Climb (45.3 %)	Outdoor: open space (57.0 %), Portable equipment (56.8 %)	Prompts: all prompts (42.0 %)
Sedentary	Sit/squat (71.8 %)	Indoor: art (97.5 %)	Group composition: non-solitary (61.2 %)
	Stand (69.8 %)	Group time (96.0 %)	Initiator of activity: adult (70.2 %)
	Walk (68.1 %)	Outdoor: sandbox (58.2 %), Sociodramatic props (55.2 %)	Prompts: no prompts (60.1 %)

Prevalence (%) of observations ($N = 15{,}824$) at different activity intensity levels

MVPA = moderate to vigorous physical activity, levels 4 and 5; light = level 3; sedentary = levels 1 and 2. Group composition (solitary vs. non-solitary); initiator of activity (child vs. adult); prompts (no prompts vs. all prompts)

levels. An outdoor location associated positively with children's activity levels in both seasons ($p < .001$). In the autumn, children were less active in the afternoon compared to morning, while in the winter, the children's physical activity levels were unaffected by time of day. Similarly, child-initiated play was positively associated with physical activity in the autumn but not in the winter. Solitary play had a stronger association with the higher activity levels in the autumn, although the influence was significant in both seasons. All prompts (both positive and negative) were associated with an increase in physical activity in both seasons in comparison to observations where no prompts were observed. Finally, temperature associated with children's physical activity levels in the winter but not autumn, whereas rain had no influence on physical activity during either season (see Table 3).

Discussion

Physical Activity Levels in Childcare

In line with earlier studies (Brown et al. 2009; Pate et al. 2008), the present study found that, for most of the childcare day, the children's physical activity levels and their activity types were sedentary in nature, with moderate to vigorous physical

Table 3 Children's mean physical activity intensity in autumn and winter: three-level linear regression ($N = 81$)

Observed categories	Autumn			Winter		
	Regression coefficient	p value	95 % confidence interval	Regression coefficient	p value	95 % confidence interval
Girl	−.16	.004	−.27 ± −.05	−.12	.017	−.22 ± −.02
BMI	.01	.544	−.03 ± .06	.02	.304	−−.02 ± .07
Outdoor	.40	<.001	.36 ± .44	.49	<.001	.46 ± .53
Afternoon	−.05	.033	−.09 ± −.00	−.02	.265	−.06 ± .02
Solitary	.11	<.001	.07 ± .15	.05	.003	.02 ± .09
Adult initiated	−.18	<.001	−.23 ± −12	−.01	.750	−.06 ± .04
No prompts	−.40	<.001	−.46 ± −.34	−.49	<.001	−.64 ± −.33
Temperature	−.01	.079	−.02 ± .00	−.01	<.001	−.01 ± −.00
Rain	−.06	.067	−.11 ± .00	.03	.338	−.03 ± .10

Girl versus boy; BMI (body mass index; linear), outdoor versus indoor; afternoon versus morning; solitary versus non-solitary; adult initiated versus child initiated; no prompts versus all prompts; temperature (linear); rain versus cloudy but dry or sunny with clear sky

activity accounting for only 2 % of all observations. The results further showed that, in the winter, the children spent significantly more time in sedentary-level activities than in the autumn. The seasonal variation in physical activity levels was more pronounced during the outdoor observations than indoor observations. The association on physical activity levels of the significant interaction between time of day and season showed that in the autumn, the present sample of children was more physically active in the morning than afternoon, while in the winter their physical activity levels were unaffected by time of day.

Indoor Environment

The most common activity types—sitting, standing, walking—and the indoor context were primarily sedentary in nature: 86 % of indoor activities were observed as sedentary. This level of sedentariness is similar to that reported in US by Brown et al. (2009), and considerably more than found by Gubbels et al. (2011) in their Dutch study. Children were sedentary when engaged in art or in large group activities organised or led by a teacher. Although several activity types and contexts were associated with higher physical activity levels, children were rarely observed indoors in activities such as running, climbing, pulling or pushing. One potential explanation relate to the childcare facilities and behavioural rules. For safety reasons, running or climbing indoors is likely to be prohibited, while indoor spaces are often small rooms with narrow corridors. Nevertheless, a place in hallways and corridors for children's play and physical activities is commonly found. To enable children to move around freely and engage in physically active play indoors,

childcare centres need to optimise their indoor space specifically for these purposes (Gubbels et al. 2012). Although Finnish childcare centres mostly have a large room or hall with gross motor equipment for physical activity and play, children, in groups, typically use them only once a week, during a structured physical education lesson, as laid down in the recommendations for physical activity in early childhood education (2005). Moreover, in its current format, physical education plays a very small role in meeting the physical activity requirements of pre-schoolers (Van Cauwenberghe et al. 2012).

Outdoor Environment

In line with previous studies (Boldeman et al. 2006; Brown et al. 2009; Hinkley et al. 2008; Pate et al. 2004), the present sample of children was physically more active outdoors than indoors. Outdoor locations had a strong positive association with higher physical activity levels in both seasons. However, even during outdoor play, nearly half of the children's activities were recorded as sedentary, and only 2 % as moderate to vigorous physical activity, which is much lower than the 17 % found by Brown et al. (2009), 21 % by Gubbels et al. (2011), and 12 and 21 % by Nicaise et al. (2011). Outdoor engagement at the sedentary level included children playing in a sandbox and/or playing with sandbox materials and activities with sociodramatic play props. Touching, riding, or pushing wheeled toys such as tricycles, scooters and wagons showed higher levels of physical activity. However, wheeled toys were used less frequently than fixed equipment such as the sandbox. This might be explained by the fact that the sandbox is available at all times, while scooters and wagons are held in storage. Children have to fetch these items and return them after use. Gubbels et al. (2012) showed that children were significantly more active when jumping equipment was continuously present, and when a fixed track was marked on the playground. Similarly, Nicaise et al. (2011) concluded that activity-genic portable equipment and riding vehicles appeared to foster moderate to vigorous physical activity. A playground redesign, which utilises multicolour playground markings and physical structures, may be a suitable stimulus for increasing children's recess physical activity levels (Ridgers et al. 2007). Scheduling recesses to minimise the number of children sharing playground or play equipment (Cardon et al. 2008), and minimise the time spent in sedentary locations, such as the sandbox (Cosco et al. 2010), may also help to increase children's engagement in moderate to vigorous physical activity (Nicaise et al. 2011). In this study, in the autumn, the use of wheeled toys was more pronounced than in winter. In winter, snow, ice and cold weather do not present the same possibilities for their as in autumn. In the winter, children were more involved with portable equipment such as sleds. Finnish childcare centres have the possibility to utilise the natural environment, such as the forest, in their daily programme. During wintertime, children often play with snow or mounds of snow, and push and pull sleds. Furthermore, it is not rare to encounter young Finnish children in childcare skating or skiing. However, at the age of three, skiing and skating involve lower levels of physical activity, such as balancing and learning to slide, than vigorous physical activity.

Weather Conditions

In the present study, the differences between the autumn and winter mean temperatures were significant. Temperature was significantly associated with children physical activity in winter, but not in autumn. Baranowski et al. (1993) reported that differences in children's physical activity levels were related more to time spent outdoors than to season or weather conditions. In this study, significant seasonal variations in mean temperatures could explain why the average outdoor time during childcare attendance in winter (116 min) was significantly less than in autumn (178 min). In cold weather, −20 °C or colder, children generally are not directed to play outdoors, or outdoor recesses are much shorter on such days. Shorter outdoor activity times in winter may also explain children's lower engagement in moderate to vigorous physical activity. However, in the autumn, engagement in sedentary level-activities outdoors was higher than in the winter. Although temperature was associated with physical activity, no association emerged between rain and children's physical activity levels.

Social Contexts

The majority of the observations did not include any oral prompting. In line with previous observational studies (Brown et al. 2009; Gubbels et al. 2011), prompts (both negative and positive) positively associated with children's physical activity intensity in both seasons. Moreover, our results, like those of Brown et al. (2009), showed that even if teachers were present, they very rarely, if ever, implemented teacher-arranged activities and games to enhance children's physical activity or encouraged children to engage in physical activity. Teachers may assume that children are naturally very active and that they engage in sufficient activity, and therefore, lay less emphasis on the importance for children of an active lifestyle (Pate et al. 2008). In general, children tended to be less physically active when more staff members were present or were involved in children's play (Brown et al. 2009; Cardon et al. 2008; Gubbels et al. 2011). Similarly, in this study, adult-initiated play had a negative association with the children's physical activity behaviour in the autumn, although not in the winter. In the winter, the children showed significantly more sedentary-level activity and engaged less frequently in moderate to vigorous physical activity during child-initiated activities, whereas adult-initiated play showed no seasonal variation in physical activity levels. Furthermore, in both seasons, children's solitary play was associated with increased physical activity levels, as also noted by Brown et al. (2009) and Nicaise et al. (2011). In contrast, in a Dutch study, non-solitary play was associated with higher activity levels (Gubbels et al. 2011).

Gender Variations

This study indicated a significant gender difference in physical activity levels, with boys showing significantly higher levels than girls. In line with the present findings, boys have generally been reported to be more active than girls (Hinkley et al. 2008;

Oliver et al. 2007; Pate et al. 2004, 2008). Currently, there is no definitive explanation why girls participate less in physical activity than boys (Pate et al. 2004). Observational studies have demonstrated that boys are more interested in playing rougher games, engage in more risk-taking behaviour and play in larger groups and in more open settings than girls (Pate et al. 2004). Also boys' activities may be more triggered by harder ground surfaces, which are mainly used for sports-related, competitive activities (Cardon et al. 2008). One potential explanation may found in teachers' attitudes, which may affect children's physical activity behaviour. It is possible that boys are regularly encouraged to engage in more physically active play and games, whereas girls are exposed to stationary activities and expected to behave in a calmer manner (Pellegrini and Smith 1998). Sandberg and Pramling Samuelsson (2005) found that despite emphasising the importance of creating inspiring environments for play and outdoor play, preschool teachers' participation in play differed by gender. For instance, male teachers had more play willingness and participated more in physically active play, whereas female teachers tended to prioritise calm play, which, for the most part, they also experienced in their own childhood (Sandberg and Pramling Samuelsson 2005). Cardon et al. (2008) also found that girls preferred to stay close to their supervising teachers, who commonly supervise sitting down or standing still, and that this might be one cause of the lower levels of physical activity in girls. It remains unclear whether the gender difference in physical activity is biologically based or environmentally determined, or a combination of both (Timmons et al. 2007).

Strengths and Limitations

The assessment of young children's physical activity is challenging, primarily because their behaviour is spontaneous, intermittent and sporadic. The benefit of the observation format used in the present study was that it recorded not only the intensity of activity, but also *where*, *how* and *in what kind of interaction* the activity was being performed. Moreover, the OSRAC-P has been shown to be a valid and reliable tool for measuring physical activity among preschool-aged children (Brown et al. 2006; Pate et al. 2010; Trost 2007). A major strength of this study was the use of a repeated-measure design, where the same 3-year-old children were measured using direct observation during two distinct seasons. However, one should be cautions when comparing physical activity levels over short time periods (e.g., 3–6 months), as children's normal growth and maturation may influence their physical abilities and motor skills in relation to their engagement in physically active play (Fisher et al. 2005). It should also be noted that the direct observations subjective, although, the inter-rater reliabilities indicated substantial agreement and a validated observation protocol was deployed (Brown et al. 2006). Furthermore, the generalizability of the findings could be limited by the fact that all the participating childcare centres and children were located in the same city. Finally, the children's behaviour could have been influenced by other factors that were not taken into account in this study. For instance, fundamental motor skills (Stodden et al. 2008) and the educational level of teachers (Dowda et al. 2004) have been found to have an influence on children's physical activity behaviour, but these were not taken into

account in this study. Therefore, the interaction between motor skills and/or educational levels of teachers and children's physical activity behaviour in different contexts merits further examination.

Conclusion

The present findings have important implications for the development of physical activity interventions aimed at increasing preschool children's physical activity behaviour in the childcare centre setting. Our findings yield comprehensive behavioural and contextual information on a sample of 3-year-old preschool children. A notable proportion of the activities observed as sedentary in the sample may encourage teachers to work towards reducing the time children spend in sedentary level and increasing time and opportunity for engaging in the higher levels of physical activity. Childcare centres offer good opportunities to increase children's physical activity and also support their learning. Childcare organisations in collaboration with families can use the findings of this study as a basis on which to promote children's physical activity. Interventions should focus on enhancing children's outdoor time, free play and positive prompting and encouragement by teachers. To enhance children's all-year-round physical activity, such changes should, in particular, target wintertime, given its consistently lower activity levels.

Conflict of interest The authors state that they have no conflicts of interest.

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